

Claims

1. An automatic gain controller for an imaging system capable of producing successive frames of images, wherein said imaging system has an illumination source, said automatic gain controller comprising:

5 means for receiving frames of images and converting each of said frames into pixels in which each pixel has a brightness value;

means for counting the number of pixels of each frame of the image which have a brightness value above an upper threshold to provide a first value, the number of pixels of each frame of the image which have a brightness value below a lower threshold to provide a second 10 value, and the total number of pixels of the frame;

means for comparing the first value with a third value representing a first percentage of the counted total number of pixels, and comparing the second value with a fourth value representing a second percentage of the counted total number of pixels; and

15 means for providing one or more signals to the imaging system capable of directing the imaging system in accordance with said comparing means to reduce the power to said illumination source when the first value is greater than the third value and the second value is greater than the fourth value, and to increase the power of said illumination source when the second value is less than the fourth value and the first value is less than the third value.

20 2. The automatic gain controller according to Claim 1 further comprising a computer system which operates the illumination source in accordance with said signals.

25 3. The automatic gain controller according to Claim 1 wherein said signals are digital signals and said providing means further comprises means for producing an analog signal based on said digital signals to said illumination source to adjust the power of the illumination source.

30 4. The automatic gain controller according to Claim 1 further comprising means for limiting said pixels counted by said counting means to ones of said pixels in a region of each frame of said images.

5. The automatic gain controller according to Claim 1 wherein said comparing means is enabled after each said frame received.

5 6. The automatic gain controller according to Claim 1 wherein said first percentage is about 12.5% and said second percentage is about 50%.

7. The automatic gain controller according to Claim 1 wherein said brightness value of each pixel ranges from 0 to 255, and said first threshold is about 250 and said second 10 threshold is about 10.

8. An automatic gain controller for an imaging system capable of producing successive frames of images, wherein said imaging system has an illumination source, said automatic gain controller comprising:

15 means for receiving frames of images and converting each of said frames into pixels in which each pixel has a brightness value;

means for counting the number of pixels of each frame of the image which have a brightness value above an upper threshold to provide a first value, the number of pixels of each frame of the image which have a brightness value below a lower threshold to provide a second 20 value, and the total number of pixels of the frame; and

a computer system coupled to said illumination source for controlling the illumination provided by illumination source in accordance with said first value, said second value, and the counted total number of pixels.

25 9. The automatic gain controller according to Claim 8 wherein at least said counting means in operative over less than the entire frame of each of said images.

10. A system for imaging an object comprising:
a source for illumination;

optics for scanning the illumination to the object and receiving returned illumination representing at least one section of the object;

means for detecting the returned illumination and forming a signal representative of an image of the section of the object;

5 means for displaying said image of the section of the object in accordance with said signal; and

means for automatically controlling the intensity of said illumination source in accordance with a characteristic of the displayed image.

10 11. The system according to Claim 10 wherein said characteristic is brightness of the displayed image.

12. The system according to Claim 10 wherein said optics represent confocal optics and said detecting means represent confocal detecting means.

15 13. The system according to Claim 10 wherein said system is adapted for imaging by one of confocal microscopy, optical coherence tomography, and two-photon microscopy.

14. The system according to Claim 10 wherein said object represents tissue.

20 15. The system according to Claim 10 wherein said means for automatically controlling said illumination source comprises:

means for providing pixels representing at least part of the image in accordance with said signal in which each of the pixels has a value;

25 means for counting the number of pixels of each frame of the image which have a value above an upper threshold to provide a first value, the number of pixels of each frame of the image which have a value below a lower threshold to provide a second value, and the total number of pixels of the frame;

means for providing a third value representing a first percentage of the total counted pixels;

means for providing a fourth value representing a second percentage of the counted total pixels; and

means for adjusting the power to said illumination source in accordance with said first, second, third and fourth values.

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16. The system according to Claim 15 further comprising means for limiting said pixels counted by said counting means to ones of said pixels in a region of each frame.

10 17. The system according to Claim 10 wherein said means for automatically controlling said illumination source comprises:

means for providing pixels representing at least part of the image in accordance with said signal in which each of the pixels has a value;

15 means for counting the number of pixels of each frame of the image which have a value above an upper threshold to provide a first value, the number of pixels of each frame of the image which have a value below a lower threshold to provide a second value, and the total number of pixels of the frame; and

20 a computer system coupled to said illumination source for controlling the illumination provided by illumination source in accordance with said first valve, said second valve, and the counted total number of pixels.

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18. The system according to Claim 17 further comprising means for limiting said pixels counted by said counting means to ones of said pixels in a region of each frame.

25 19. The system according to Claim 10 wherein said controlling means comprises:

means for providing pixels representing at least part of the image in accordance with said signal in which each of the pixels has a value;

means for summing the value of the pixels of each frame to provide a summed value;

means for counting the number of pixels in each frame;

means for determining an average pixel intensity in accordance with said summed value

30 and said counted number of pixels; and

means for adjusting the power to the illumination source in accordance with said average pixel intensity.

20. The system according to Claim 16 further comprising means for limiting said 5 pixels summed and counted to ones of said pixels in a region of each frame, wherein said average pixel intensity is representative over said region.

21. The system according to Claim 10 wherein said means for automatically 10 controlling said illumination source is enabled for each successive ones of the image to effect the characteristic of said successive ones of the image on the display.

22. An automatic gain controller for an imaging system capable of producing images of tissue in which said imaging system has an illumination source for enabling said imaging system, and said automatic gain controller comprises:

15 means for determining the number of pixels which are bright and dim in an image; and
means for controlling the illumination provided by the illumination source in accordance with said number of pixels which are bright and dim in the image.

20. An automatic gain controller for a imaging system capable of producing successive frames of images, wherein said imaging system has an illumination source, said 25 automatic gain controller comprising:

means for receiving frames of images and converting each of said frames into pixels in which each pixel has a brightness value;

means for summing the brightness value of the pixels of each frame to provide a summed 25 value;

means for counting the number of pixels in each frame;

means for determining an average pixel intensity in accordance with said summed value and said counted number of pixels; and

means for controlling an illumination source of the confocal imaging system in 30 accordance with said average pixel intensity.

24. The automatic gain controller according to Claim 23 further comprising means for limiting said pixels summed and counted to ones of said pixels in a region of said image.

5 25. A method of controlling an illumination source of an imaging system capable of producing successive frames of two-dimensional images, wherein said imaging system has an illumination source, said method comprising the steps of:

- a) receiving frames of images and converting each of said frames into pixels in which each pixel has a brightness value;
- 10 b) counting the number of pixels of each frame which have a brightness value above an upper threshold to provide a first value;
- c) counting the number of pixels of each frame which are below a lower threshold to provide a second value;
- 15 d) counting the total number of pixels of each frame;
- e) providing a third value representing a first percentage of the counted total number of pixels;
- f) providing a fourth value representing a second percentage of the counted total number of pixels;
- 20 g) comparing the first value with said third value;
- h) comparing the second value with said fourth value; and
- i) controlling an illumination source of the imaging system which produced said frames of images in accordance with said steps (g) and (h) to reduce the power to said illumination source when the first value is greater than the third value and the second value is greater than the fourth value, and to increase the power of said illumination source when the second value is less than the fourth value and the first value is less than the third value.

25 26. The method according to Claim 25 wherein said steps (b) through (d) are operative over less than the entire frame of each image.

30 27. A method for imaging an object comprising the steps of:

providing a source for illumination;
scanning and focusing the illumination to the object;
receiving returned illumination representing at least one section of the object;
detecting the returned illumination and forming a signal representative of an image of the
5 section of the object;
displaying said image of the section of the object in accordance with said signal; and
automatically controlling the intensity of said illumination source in accordance with a
characteristic of the displayed image.

10 28. The method according to Claim 27 wherein said characteristic is brightness of the
displayed image.

15 29. A method for automatic image quality control for a imaging system capable of
producing successive frames of images in which said imaging system has an illumination source,
said method comprising the steps of:

20 providing frames of images in which each of said frames is represented by pixels having a
brightness value;
summing the brightness value of the pixels of each frame to provide a summed value;
counting the number of pixels in each frame;
determining an average pixel intensity in accordance with said summed value and said
counted number of pixels; and
controlling an illumination source of the confocal imaging system in accordance with said
average pixel intensity.

25 30. The method according to Claim 29 further comprising the step of limiting said
pixels summed and counted to ones of said pixels in a region of said image.